Demonstrating Value: How to Use Benefit-Cost Analysis to Evaluate Energy Mitigation Projects

Webinar Transcript

Virginia Castro: Good afternoon everyone. This is Virginia Castro I am a technical energy project specialist with the U.S. Department of Energy state energy program. Thank you for joining our two part webinar series, the second of our two part webinar series, Demonstrating Value: How to Use Benefit-Cost Analysis to Evaluate Energy Mitigation Projects. Before we get started, we have a few technical instructions for you. If you have questions during the presentation, please submit them via the Q&A pod under the attendee list on the left side of your screen. We will be collecting your questions throughout the presentation. They will inform our Q&A discussion at the end of the session.

Next, I would also like to point out you can download a pdf of today's presentation as well as last week's presentation from the downloads pod located in the bottom right area of your screen along with several other resources. Please note that this webinar is scheduled until 4:00 p.m. Eastern. However, depending on the amount of feedback and questions we receive from you, we may wrap up a little bit earlier. Following the presentation, we also request your feedback on the webinar with a few short poll questions. The questions are optional, but we greatly appreciate your feedback. It helps us make future webinars even better. All right. With that, let's get started. For those of you who joined last week in part one, Mitigating Natural Hazard Risks in the Energy Sector, Innovative Projects That Help Build Resilient Communities, welcome back. To everyone on the webinar today, thank you again for taking time to join us.

This webinar series is a product of a collaboration between the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, Weatherization, Intergovernmental Programs and FEMA, the Federal Emergency Management Agency Hazard Mitigation Assistance Division and is intended for federal, state, tribal, local community officials interested in learning about innovative energy specific hazard mitigation projects and metrics. Last week our discussion was focused on programs and projects. Today we'll focus our discussion on metrics for evaluating potential energy specific hazard mitigation projects. In today's presentation, we'll hear from Tara Seibold, a policy analyst with FEMA's Hazard Mitigation Assistance division. Tara will discuss FEMA's benefit-cost analysis, BCA, program guidelines, methodologies, and tools for evaluating energy mitigation lifeline projects.

While the BCA toolkit is used for FEMA's Hazard Mitigation Assistance programs and public assistance grant programs, it has a broad range of applications for other federal agencies, for states, tribes, local governments. Participants today will learn to use the BCA toolkit as it applies to energy sector projects to build resilient communities. Lastly, I would like to take a moment to thank our colleagues at FEMA for sharing their expertise and hosting this platform for this webinar series to bring together state energy offices and state hazard mitigation offices virtually. With that, I will turn the presentation to Tara.

Tara Seibold: Hi, I'm Tara Seibold. Thank you all for joining us. As Virginia said, I work with the Hazard Mitigation Assistance division as part of our benefit-cost analysis program. Today I will be giving an overview of the BCA toolkit, some of the background on how to do an energy

lifeline mitigation project and demo of the BCA toolkit. So, for those of you who were not able to join last week or who would like a refresher, FEMA's Hazard Mitigation Grant Program helps FEMA's mission of supporting people before, during, and after disasters. The goal of hazard mitigation is to protect life and property from future disaster damages and to reduce risk from disasters. FEMA has three programs that fall under the Hazard Mitigation Assistance bucket that specifically fund hazard mitigation. The first is the Pre-Disaster Mitigation program which will be replaced by the Building Resilient Infrastructure and Communities program or BRIC in fiscal year 2020. So next year. This is an annual competitive all hazards grant program. The second is the Hazard Mitigation Grant Program. This is an all hazards mitigation program available after every presidentially declared disaster. Third is the Flood Mitigation Assistance program. This is an annual competitive program similar to PDM and BRIC that focuses on flood risk, specifically for the purpose of reducing damages and claims to National Flood Insurance Program. FEMA does hazard mitigation through the Public Assistance program so that's for mitigation of damaged public infrastructure.

Virginia: Thank you Tara. This is Virginia Castro. At the federal level, this slide illustrates DOE's role as serving emergency support function 12 in times of a disaster because of the Department of Energy expertise. Energy lifeline has three parts to it. Power grid, temporary power for critical facilities, as well as for fuel. The lifeline enables continuous operation of government functions and critical business and is essential to human health and safety for economic security. Tara: So why does FEMA require a benefit-cost analysis for mitigation projects? There are a number of reasons to do a BCA. It can help decide between multiple projects. It can help get support from a community. Another reason that we require this is we have a statutory requirement laid out in the Stafford Act which is the law that authorizes all of these programs. FEMA has to fund cost effective projects.

FEMA uses the benefit-cost analysis process to show the cost effectiveness of hazard mitigation projects in accordance with the White House Office of Management and Budget, Circular A94, which provides guidelines on what constitutes a benefit-cost analysis and how to do it. So, the benefit-cost analysis process is the process of quantifying benefits of an action and comparing it to its cost. This results in a benefit-cost ratio or BCR. So, the BCR is the benefits of a project divided by the cost of that project.

So in this case that's the cost to implement the project. In order to be eligible for FEMA funding, hazard mitigation projects must have a BCR of at least 1.0 or greater. If you are not applying for FEMA funding, it is not necessarily required to have a BCR of 1.0 or greater. However, there are reasons to only fund projects with a BCR of 1.0. So, FEMA's BCA Toolkit to facilitate the process of preparing a BCA for states, local tribes and territories, FEMA has developed software called the BCA Toolkit. We are currently on version 6.0 of the BCA Toolkit. This is an Excel based tool that calculates benefit-cost ratio for hazard mitigation projects.

Some of you might be familiar with the previous version 5.3. I would like to point out that we are still accepting BCAs done in 5.3 for this cycle of PDM and FMA. However, after this year we will only be accepting BCAs done from version 6.0. It is to your benefit to start transitioning to 6.0 and familiarize yourself with the new toolkit. Our primary users are FEMA grant applicants however, this toolkit can be used to analyze any hazard mitigation project regardless of size or funding source. You can use this toolkit to analyze a $20,000 project as easily as you can to analyze a $20 million project. It's been used by other federal agencies. We do not restrict it to FEMA projects only but that is the main use.

Having a BCA is a required component of FEMA hazard mitigation grant applications. There are a few exceptions for example if you are updating a hazard mitigation plan, but it is required for all FEMA mitigation projects that involve instruction or structural component. Department of Housing and Urban Development community development block grant mitigation funding their grant applicants may also use the BCA toolkit to validate cost effectiveness. The requirements are laid out in their CDBG mitigation notice of funding opportunity. How is the BCR calculated?

Again, the BCR is the benefits divided by the cost. This equation is deceptively simple. First of all, what counts as benefits? There are certain things that might be benefits to a local community that do not count as benefits from FEMA's perspective. The other thing to note is FEMA does count all benefits regardless of who is benefiting so we do not restrict this to benefits just to the federal government. This can be benefits to federal government, state governments, locals, individual homeowners as well. How do we quantify these benefits? For example, how do we quantify the value of electrical power? FEMA does have methodologies for quantifying benefits as well.

This calculation benefits divided by cost doesn't really seem to take into account things like project useful life, how long the project is going to last, project effectiveness, to what level project provides protection, hazard risk and probability, how often this is going to occur, and the discount rate. The BCA toolkit however does take all those things into account. When it is giving you your benefits divided by your cost, it is accounting for all those things as well. So, what counts as benefits? Benefits in a FEMA BCA are any future costs, losses, or damages avoided as a result of the mitigation project. These future costs or losses can include direct damages which are also called physical damages. For example, to the structure itself or damages to the contents of a structure.

They can include displacement costs. For example, if a person's home is damaged, how much does it cost to put them in a hotel and to feed them? Loss of function or loss of service for utilities, roads, bridges, infrastructure, or really any type of facility that provides a service to the public. Emergency management costs. For example, sand bagging or costs to block off roads or redirect traffic. Then deaths and injuries for certain types of hazards can be quantified. What would this look like for an energy mitigation project? Well, for example if a community strengthens power lines whether through undergrounding or by hardening them against high wind events or ice storms, that community is less likely to lose power in the event of a disaster or other type of hazard event.

Not only does electrical service itself have a value that can be quantified, there might also be fewer repair costs and emergency management costs. This can be sending workers to close a road with live wires, redirecting traffic, or cleaning up debris. These avoided costs would be included as benefits of the mitigation project. Once the mitigation project is completed, you no longer have to send those people out to do that type of repair work. So, some potential damages you might expect from a power outage, the first is going to be loss of electrical service. In a lot of cases that will provide majority of your benefits. Loss of function for public services.

Again, if a police station loses power because the lines fail, there is a cost to the community for losing that police service. This can also include fire stations, EMS, hospitals, transportation such as airports and roads, public buildings, any sort of public facility. If they lose power, they can no longer provide that service and that does have a cost. Contents damages. This might be spoiled

food or electronics damages. Those can be included as well so the damages would be the cost to replace whatever gets damaged. Displacement cost. Again, for residential structures, this is the cost to stay in a hotel and then to feed however many people are displaced. For public facilities, this would be whatever costs are for moving to a temporary location in order to operate elsewhere. Repair costs. Whatever it costs to repair the structure to get back up and running.

Then emergency management and response costs, if the police have to work overtime to direct traffic, that time can be quantified as a cost as well. So quantifying loss of service, there are multiple ways to do this depending on the type of facility. For electrical service however we do have a standard value. The value is $148 per person per day. It is important to note that when looking at the loss of electrical service, the number of people is not necessarily the same as the number of rate payers.

For example, if the average household has 2.5 people living in the house, you might want to take the number of rate payers and multiply that by 2.5. You know all those people would be losing power and would therefore benefit from the power staying on. You can also use U.S. Census data to estimate the number of people that might lose power and not have to use number of rate payers and convert that into a person amount. This is an estimate of the value to society of electrical service.

This does take into account residential, industrial, and commercial uses. If you would like more information about how this value is developed, we do have a standard values methodology report which you can request from the BCA help line. The e-mail address for the help line is below and it is also on our website. We do update these values periodically to adjust for inflation and other changes. What do not count as benefits for the purpose of FEMA BCAs. If you are not applying for FEMA funding, you might be able to include these, but these are not allowable as benefits for FEMA funded hazard mitigation projects. Secondary effects of the project. For example, increased employment, increased or decreased tax base or economic growth are not allowable. Those are what's known as indirect benefits. Those cannot be included in a FEMA BCA.

Anything that is not quantifiable, aesthetic value of a project or increased resilience. That might be a significant benefit of the project, but you would have to quantify in other terms how it is increasing the resilience for example by decreasing power outages. Energy cost savings. While these might be the primary benefits of other types of projects or grant programs, you cannot include energy cost savings in a FEMA BCA nor can you include reduced insurance premiums.

These are what are known as transfer payments. Instead of reducing risks or costs, you are transferring them to someone else. Reduced pollution or greenhouse gas emissions also cannot be included in a FEMA BCA. These might be quantifiable but are often hard to tie to the project directly, so these are also not allowed. So, some background on our BCA toolkit, in 1999, the GAO published a report that FEMA's BCA methodology and process were not standardized and were difficult for users to do a BCA.

So FEMA developed the BCA toolkit as a way of standardizing the methodology and making it easier for states, locals, tribes, and territories to do this. In 2006 to 2008 or so, FEMA reengineered the BCA toolkit and established the currently used methodologies, equations, and standard values. We have updated some of the information in the toolkit since, for example, the hazard information, hurricane wind speeds, earthquake risks, and tornado counts. We update those annually or whenever that data is available but the basic methodologies and equations

were reevaluated and reengineered in 2006 and 2007 using subject matter experts and a panel who would then approve the methodologies. All BCAs performed in the BCA toolkit do comply with the guidance laid out in OMB circular A-94. If FEMA does require that you use the BCA toolkit unless you have preapproved in writing that you can use a different methodology. That's only allowable when the FEMA methodology cannot actually quantify your benefits.

The newest version of the toolkit is version 6.0. This is an Excel based add in. You can use it in Microsoft and Mac. That's new from version 5.3. You can download it at this website, the FEMA BCA website. The tool calculates a benefit-cost ratio for a project by estimating the damages before and the damages after mitigation. That is the benefit of the project and dividing it by its cost. Again, the BCR is benefits divided by cost. Benefits are damages before mitigation minus damages after mitigation.

Before we got into the BCA toolkit itself, we are going to kind of step back a little bit. We will cover the specific data requirements. But first it's helpful to kind of consider these questions when doing your BCA as a way of framing your project and making sure you thought through it properly so you can include all potential benefits. What is the overall intent of your project? This is not necessarily the same as the physical work being performed. For example, your intent might be to reduce power outages.

You can achieve that through multiple different projects. You can use generators, under grounding power lines, hardening power lines. There are different ways to achieve the same goal, so it is important to keep that in mind when doing your BCA. What is the actual goal or intent of your project? What are the facilities or public services that will be protected by the project? This can be utilities, fire station, police stations, government services, hospitals, businesses, etc. It's important to understand all the facilities that will be protected by your project so you can capture those in your BCA.

We often see projects that do not capture all the benefits. It's very important to do this, to make sure you really have an understanding of all the structures that will be protected by your project or impacted by your project. What is the level of effectiveness of your project? This is also known as the level of protection. All projects have a point at which they will fail. If you are elevating a generator, at some point the flood waters will hit the generator. If you are hardening power lines against ice storms or high wind events at some point they will still fail. You do have to know at what point that is going to happen in order to accurately calculate your BCR. What damages occurred that can be directly tied to the hazards being mitigated? This is also important.

If your project will not reduce damages from a certain type of event, you cannot include those damages in your BCR. If your project is dry floodproofing you cannot include outages or damages from a high wind event because that might still cause outages. What are the data that you need for a mitigation project? This depends somewhat on the type of project you are doing. But there are some data points that you will always need. You need to know the project location and the hazard being mitigated.

For energy projects, this is generally not going to impact your BCR. This is more of a way of keeping track of your project. For other types of projects though, the project location can impact your BCR, so it is important to use the actual project location. This can be an address but it can also be a latitude and longitude coordinate depending on, for example, if it's a facility or a road that might not have a physical address. You can also use GPS coordinates. You need to know

the project cost. This is important because this is the divider in the BCR ratio. You also need to know the project useful life which is how long the project is going to be effective. The BCA toolkit help content does provide standard values for many different project types. It also provides a range of acceptable values, so this information you would probably get from the project engineer or the manufacturer depending on the type of project you are doing.

For each facility being protected, you need to know the year in which it was built, the number of customers or annual budget depending on facility type. You also need to know past or estimated damages. This is either in dollars or number of days service impacted depending on the type of facility. Preferably these damages should be associated with recurrence intervals. If they are not associated with recurrence intervals, you do have to know the year in which the damages occurred.

You also need to know the level of project effectiveness. So what will the damages be after the project and when will those damages occur? Then for getting more into the path to expected damages, the software to calculate the benefits of the project, the software bases it on past or expected damage amounts entered by the user. Again, these must be damages that would be mitigated by the project. If the power lines got chewed through by a squirrel and you are not under grounding them, then the squirrel can still chew through the power lines. That is not a kind of damage that can be mitigated by your project.

Again, the damage amounts should be associated with a recurrence interval. For example $60,000 of damage in the 1% annual chance storm. If they're not associated with a recurrence interval, you do have to know the year in which the damages occurred. The recurrence interval is likelihood of a hazard event of a specific severity at a specific location. Recurrence intervals are location specific. A 100-mile per hour storm will have a very different recurrence interval in say Florida than it will in Washington, DC.

So you do need to know your recurrence interval for that specific location. If you do not know the recurrence interval for any of your past damage events, you will need at least three past events and the software will calculate the recurrence interval for you. If you do not have three events you will always get a BCR of 0 because the software cannot calculate your damages without any recurrence intervals. It does not know how to estimate it. What it does is it fits the damages to a curve to see how often it expects those damages to occur over the life of the project. Having recurrence intervals is very important.

Virginia: Thank you. Tara. Tara: The benefits, for project effectiveness, damages after mitigation, these are an important component. Because in order to properly estimate the damages after mitigation, again, the software needs to know at what point it will fail. The recurrence interval and then the damage amount in dollars or number of days service impacted are what you need for project effectiveness damages after mitigation.

So for example, if your project would protect to the 100-year wind speeds then you might start getting outages at the 101 year wind speed. Or in the 500-year event, you might expect one day of lost service even after the project is complete. These are called residual damages, residual risk, level of protection, project effectiveness. Those terms are used fairly interchangeably. In most cases, this needs to be determined by your project engineer. Sometimes you do not need a project engineer. Again for example if you are elevating a generator or building some sort of flood barrier, if you have a flood insurance study you would know at what point the floods will

overtop that barrier or will reach the generator but you would still need an engineer to determine the loss of service that you would get in that event.

Virginia: Thank you Tara. I just wanted to highlight a reminder to participants that we will be fielding your questions at the end of the presentation section. I encourage you to submit your questions at any point during the presentation via the Q&A pod on the left side of your screen. We'll then do our best to answer as many questions as we can during the Q&A session. Thank you.

Tara: We are going to do a demo. But before we do that, I am going to run through some of the basic information that we require just so you can get a sense of the type of information you will need and how that changes based on structure type. If we were developing a campus micro grid, some sort of grid that could operate independently of the power grid if the power grid failed, we would need to know some basic information about it. How many residents are there? In this case, there are 10,000 residents. Most of the buildings are built after 1990. In addition to 10,000 residents, there is also a couple critical facilities that would be impacted by the project. Electrical service obviously, police stations, health clinics, educational facilities. All of these would benefit from having this micro grid.

So some basic project data, the micro grid is expected to last 30 years. The initial cost to build this is $2.2 million and then the annual maintenance costs are $5,000. It is important to include maintenance costs and to know what those are, averaged over the life of the project because the project will not maintain its level of effectiveness if it is not maintained. That is a component that you need to consider as well. The first structure is a utilities structure. This is specifically for electrical service. It was built in 1990, it serves 10,000 customers. It does have a past damage history. We have also gotten the after mitigation damages from the project engineer, in this case a half day loss of service in the 100-year event with some contents damage remaining. For a utility service, the impact for the primary damages is in days.

The secondary damages are generally in dollar amounts. This would be cost to repair whatever got damaged, maybe costs to pay workers overtime. Bills are going to be in dollar amounts. Primary damages are in days. These can be fractions of days as well. The contents damages, anything that is included, should be damages resulting from the power outage that are not captured under other structures. An example of that would be spoiled food in the dining hall. If that is not captured elsewhere, that can be captured here. You do want to make sure you are not double counting your benefits anywhere.

The second structure is a police building built in 1991 serving 15,000 people. This has a different service population. That's important to make note of. It also has a damage history with again a half day loss of service in the 100-year event and some remaining emergency response costs. The third facility is a health clinic built in 1994. For this type of facility instead of knowing the population served, you need to know the annual budget. That's because essentially what it is saying is that how much the public pays for this facility is how much it is worth. If the operating budget is 7 million, it is worth $7 million to the community. This also would have some loss of function in the 100-year event and it does have a damage history. The 4th structure is a school building. Anything that is defined as a critical facility in your local hazard mitigation plan can be included as a critical facility in a FEMA BCA.

If for example you identified schools as critical facilities, maybe they are going to serve as shelters, those can be included as a critical facility in the FEMA BCA. We will be using the year

built, annual budget, and the damage history to estimate the BCR for the structure. Now I will do a demo. This is the FEMA BCA toolkit. I downloaded it from the FEMA BCA website. Then I have already installed the add in. If you haven't, you would go to insert and install it from there. There are detailed instructions on how to do this on the FEMA BCA website.

Can you all see this? Now I can click on this little scale in the upper right hand corner and it's going to open a side bar. I can click open calculator and it's going to open up a second screen. Now, I have no projects. This is a blank file. But once I have projects, they will appear here on what's known as the home screen. There is also help content. Help content is always identified with this white i and a blue circle. If I click on this, it is going to give me basic information about the BCA process.

What is a BCA and a BCR? What are considered project benefits? What are considered costs? This information is dynamic. If I am on a different screen, I will see different health content appear. I can click the x and go back to my home screen. Now I can click add project and it is going to take me to the project configuration page. This is where I start entering in my project specific information. So my project title for this one can be micro grid resilience project. Then my address is going to be FEMA headquarters. Once I start typing, addresses will start to appear. This property location bar is connected to leaflet which is a web map application service. This allows us to standardize our addresses and make sure we are getting accurate information. For example, for latitude and longitude, if I don't have an address, I can click this toggle and say use property location, no, and then I can type in latitude and longitude. Now I select the property structure type.

The first structure that we are going to do is the electrical service. For that, I would select utilities. Then I would most likely want to select infrastructure failure. The reason for this is that a micro grid would generally protect against outages from multiple times of events. It might protect it from routine power outages, flooding, or high wind events depending on how it is designed.

Really what I am mitigating here is loss of power outage because the infrastructure itself is failing and not necessarily flood specific damages so for this I will select infrastructure failure. Now because I've selected utilities, this defaulted to historical damages which is the type of data that we have. For other types of projects I might use modeled damages or professional expected damages. Model damages, it bases the damages on structure type. For example, flood depth in a house would use modeled damages for the most part. Professional expected damages I would use if I did not have a damage history but I did have documentation from an engineer or other licensed professional telling me the number of damages I could expect and the associated recurrence intervals.

For project useful life, we know this is 30. There are little comment boxes on the side as well. In the old toolkit you would attach documents to provide justification for any of the values that you entered. We got rid of that in version 6.0 because it was causing a lot of issues with the file size and uploading the BCAs. Instead, there is a comment box where you can say the letter from manufacturer or project engineer in application. This is where you would note for the BCA reviewer where to find this documentation.

This is particularly for if you are applying for a FEMA grant. Then the project cost, we are protecting multiple structures but I am going to enter the project cost all on one structure. This is because I don't necessarily know how the costs are broken out between the structures. I can break them out evenly and just say each cost is a quarter of the total cost or I can put all the

project costs on one structure the way the math breaks down is the same. So year of analysis conducted defaults to the current calendar year, year the property was built for the utility is 1990. So it is a 30 year analysis duration. If for example something changed, maybe my flow conditions changed for a flood project, I could use a different analysis duration but I would have to document why I was doing that. The type of service is going to be electrical.

The other types of service for which we have standard values are potable water and wastewater. I will select Electrical and it defaults to 148 which is the value of service per person per day. Then I know that the number of customers, number of people, which is not necessarily the same as number of rate payers is 10,000 for this particular substation or whatever this is. Then the value of service per day is 1.48 million. Then I would scroll down to historical damages before mitigation. I would start entering in my information. For the damage year, I know that the largest event or the event with the longest impact was in 2001.

There are multiple ways you can enter this information. I do recommend entering either chronologically or in order from largest to smallest because that does- sometimes the toolkit will otherwise mix the recurrence intervals up and that can cause issues. I would put in three impact days. I don't know my recurrence interval so I will leave that blank. Then I will put in $25,000 in other damages. So I can then rename this column contents dollars to show it is contents and the value is in dollars. Currently, I am getting zero dollars in annualized damages and losses. Again, it's because I don't know my recurrence interval. I need to add two more events before I start seeing any benefits.

Next, I would add in my 2016 events which had 2.5 days of lost service and $22,500 in contents damage. I would click add row again and enter my 1995 events, two days, $14,000. As soon as I click out even before, I start seeing damages. As soon as I have that third event, it starts calculating annualized damages and losses. Now I can add my 4th event, 2013, 1.5, and $10,000. It's also important to note that if you enter into events that have the same exact number of impact days or the same damage year, the math will not work properly.

What you can do, if I had two events in 2016 and one had a one day loss of service and one had a three day loss of service, if I could change the damage year for the second event to 2017 or for the first event to 2015, the difference is close enough that it is not going to actually affect your recurrence intervals if you change it by one year but it will make your BCR more accurate. The other thing you can do is if you have two half day losses of service in the same year that would both be mitigated by the project is you can combine them into one event. However, your damages need to be comparable. I would not combine a one day and a three day event but I could combine two half day events into one, one day event. Then I know that this is going to provide protection to the 100 year event.

For my expected damages after mitigation, I enter my recurrence interval, half day loss of service, and my $5,000 contents damage. Now, I am getting a benefit-cost ratio of 2.5 just from this one structure. There are however three more structures in the project. I can click finish and then I come to the project summary screen. So I see my project here and I see a map of the project location. If I want to add another mitigation action or another structure to my project I would click Add Mitigation action and it would bring me back to the configuration page for a new structure. The project title is saved. But the property location might be different. I would type in that property location.

For this one, the structure type is police, so I would select critical facility. For Hazard type, it is not letting me select infrastructure failure. This is because the default methodology for critical facility is modeled damages. However, I have historical damage data so I am going to switch to historical damages. Now when I click on hazard type, I see all of them.

So now I can select infrastructure failure. My project useful life is still 30 years. My project cost, I enter the total project cost for the project on the electrical utilities structure. So I can put in one dollar here. I do have to put in a value here or the software tries to divide by zero when you get an error message. But this will not change your overall BCR. If I want to be precise, I could subtract a dollar from the project cost for the utility project. The year the property was built is 1991. The critical facility type is police station. I would select that and I would get a number of other questions that I have to answer.

So the type of area served by the police station, so the options are metropolitan, city and rural. This is the type of information you would most likely get from the local jurisdiction, so I will select metropolitan area because I selected a DC address. How many people are served by this police station? You would most likely get this information from the police chief or perhaps your office of emergency management, office of planning, depending on the jurisdiction. I will enter in 10,000 here. How many police officers work at this station? This is essentially estimating the number, how many services are provided to the community in a regular event. And how many services would be provided to the community in the event of this station losing power?

So maybe in the event of a station losing power, they would have to have a neighboring police station split their people between the two jurisdictions so they might have half as many people. So for damages before mitigation, again, I will base this on the damage year and the emergency response cost. I can change this. 2001, three days, and $15,000. The response cost could be based on, for example, overtime pay, if they had any equipment costs that they needed to rent or to use. It could also be based on time spent doing things like redirecting traffic or closing down roads, sandbagging facilities, all of those would count as emergency response or emergency management costs that would be allowable.

So they would have to provide some sort of documentation that they had this many police officers who spent this long and then quantify that into a dollar cost. So I will do the same for that 2016 event with 2.5 days loss of function, and $19,000, the 1995 event with two days loss of police services, and $8000 and then the 2013 event with 1.5 and $7,000. Once I got to three events, the toolkit starts calculating my recurrence intervals and then it's able to provide annualized damages. The toolkit also inflates damages for any dollar values that are entered to present-day dollars.

So if you are just entering in your impact days, the toolkit will not inflate those because those are already in current dollars. If you are entering dollar values from 2000, it will inflate those to current values. Now for damages after mitigation, again, I know my recurrence interval is the same, 100, the impact is 0.5 days and the response cost would be $3,000. And now I am getting a benefit-cost ratio.

So the toolkit thinks my benefit-cost ratio is 181,000. That is because I entered in a project cost of one dollar. However, when you click finish and I go to my project summary screen, it is actually giving me a BCR of 2.59. This is because it is averaging out with total project benefits and total project cost.

So when you submit a FEMA BCR, you do not submit for every structure you submit the total project BCR so this averages the BCRs for all the structures in the project. Not every structure needs to be cost-effective on its own. The total project BCR must be 1.0 or greater. If for example my benefits for the electrical facility had not been greater than one, that would be acceptable as long as the other structures in the project were cost-effective enough to bring my total project BCR above 1.0.

So now I can add in my health clinic as well. I can click add mitigation action again. My address, my structure type for this one is again a critical facility. And I will switch to historical damages and then select infrastructure failure, project useful life is still 30, my project costs are 1. For this one the year built was 1994. For the critical facility type, I would select other. This is not fire, police, or hospital. As long as it is a critical facility identified in your FEMA hazard mitigation plan, you can include that loss of function in your BCA.

So for the service name, I would enter in the name of the facility or the service it provides. In this case, I will say health clinic. And then the annual operating budget which is 7 million, the toolkit then converts that to dollars per day in order to estimate the loss of service value of that facility. And again, the reason that we use operating budget is because we can assume that what the public pays for a facility is what it is worth to them to have.

So for the damage history, I will enter in 2001 because that's my largest event and enter in 3.5 days. So this facility has longer impact times than the other facilities but the same damages. That is acceptable as long as you can document it. For certain types of facilities, you might lose power for a day but you might need an additional half day or six hours to get the facility back up and running. Even once you have power, if you are not able to operate, you can include that as additional outage time as long as you can document it.

So if you have a wastewater facility that lost power for a day and needed an additional day to get the functions restarted, that would be allowable to include in your loss of service. There are no other damages for this facility. Then I would just add in my other damage events, so 2016, and three days, 1995 and 2.5 days and 2013 and 2 days. For the damages after mitigation a 100 year event and this would have a one day loss of function. Now I can click Finish and see my total project BCR which is currently 2.6. For the last structure, the education facility, I can again click Add mitigation action. For structure type I will select Critical Facility, I'll switch to historical damages and select infrastructure failure, enter in the project useful life, and your initial project cost.

So if I did not know my project useful life and I did not have information for my engineer what I can do is click on this button which is the help content and there is a table here that provides some project useful life value as well as acceptable limits. So if I were doing a utility mitigation project involving power lines, cable hardening, gas or water sewer lines, the acceptable documentation limit is 50 to 100 years and the standard value is 50. Now if I am purchasing some other type of equipment, the standard value is 30 years so the standard value depends on the type of project you are doing. But FEMA does provide some standard values and also acceptable limits. It also provides information on, for example, number of maintenance years and cost as well as the project configuration.

So what appears here depends not just on what screen I am on but also on which button I click. So if I click the i button here, it knows that I want project configuration help content whereas if I click the button here, it directs me to the cost estimation help content. Now I can click next, year

built, 1890, critical facility type, again, I am going to select other, school, the operating budget for this is $40 million. I will enter my past damages, damage year and impact days, and 2.5 days loss of service. Maybe for example the school lost service halfway through the day and couldn't operate for the rest of that day and the following 2 days. The toolkit is now calculating my recurrence intervals, my annualized damages.

So my damages after mitigation, 100. Because we do not know if the loss of service would happen in the middle of the day or half way through the day, we will say that they will lose a full day of service because the school may be out for a full day. So functionally, they would not be able to operate for a full day.

So then we are getting our BCR. Because we put in one dollar for the project cost, it gives us a BCR of 410,000. When we click finish, we get our total project BCR which is 2.82. Now I can look at my report. If I were submitting this to FEMA I would report in what I would submit. All of the information I just provided are all in one place. The comments, again, for my justification, which you should always do if you are doing this for a FEMA grant, these would also appear here. It includes this information for every structure that you input into your BCA. In order to save this, I would click print report. And then I would print this to a PDF. I could do Microsoft print to PDF. Click print. Save it somewhere. In this case, I will save it to my desktop. And now I can go in and open up my BCA report. Okay. And again, it is going to have the same information that was in the toolkit that I just entered.

So now I can close my report and it takes me back to the project summary screen and there are all of the structures in the project. When I go to the homepage, it will show me my microgrid resilience project. So it is important when you close out of that window to make sure you save it. The toolkit will not autosave for you so just because you hit finish in your project screen, it is not saved until you save the Excel spreadsheet. That is very important to make note of. There is a little message here reminding you of that and when you click Excel, it will ask if you want to save the file. Always say yes. You say no, your project will not save.

So remember to save your file. Now I hit save and if I close it, it is still saved. So now I will go back to the presentation and run through an example project or an actual project I believe in Puerto Rico or the USVI. Puerto Rico, yes.

So we went over the project in last week presentation and now we will go through how to do a BCA for that project. So Puerto Rico, PV & Storage Energy Resiliency Project, the project cost, approximately $240,000, now the goal of the project from a DOE perspective is to increase residential energy resiliency and reduce energy consumption from the grid. The goal from FEMA perspective is to reduce loss of power and any associated damages or loss of function that comes from that loss of power. Again, just because your project goal, the primary goal might not be risk reduction, does not mean there are not risk reduction benefits that you need to consider when doing a FEMA BCA.

So this project covered 20 homes in Cauguas and Arecibo, it did not protect any critical facilities. It was providing electrical service to those 20 homes which contained 56 people. So 20 homes times 2.81 people per household is 56 customers and 2.81 is the average household size for that area. I believe that was from census data.

So the first structure is the utility, electrical service, the past damage event. We looked at the wind speeds for hurricane Maria and estimated that for those specific parts of Puerto Rico,

those wind speeds constitute a 50-year event. So 50 years is the recurrence interval that we will use. There was $20,000 of contents damage, $1,000 per home. There was a 75 day loss of power, $481,500 dollars in displacement costs this cost was calculated using standard per diem rates.

So for the continental U.S., those are calculated using GSA standard lodging rates for that particular area, town, county, for most of the territories including Puerto Rico those are calculated using Department of Defense rates.

So for these 20 households, it was $167 for lodging times 75 days so that is $250,000 approximately and then for food, so 56 people times $56, $55 per day, time 75 days, so $231,000. Displacement costs can be quite high.

So if they are applicable, it is a good idea to include them in your project, especially for long-term outages such as this. For the first structure, this is the utility electrical services, the after mitigation damages in the 100 year event, the project engineer estimated there would be a half-day loss of electrical service, $5,000 in contents damages and no displacement cost. So now we will go back into the BCA toolkit and because I saved my last project, it appears here.

So now I can click add project and for this one I can enter Puerto Rico PV project. Now for my address, I enter in that. I do not actually know the ZIP Code for Puerto Rico off the top of my head. I will enter in - in this case, it will not make a difference. For some projects, however, it does make a difference. 00725 for Cauguas.

So now for structure type, I would select utilities for hazard type, infrastructure failure, and again it defaults to historical damages. So it looks like I don't know the project useful life for this. I can, however, go into our project useful life table and look up utility mitigation projects. This is a major project involving power lines and hardening so I can say 50 years is the FEMA standard value. The reason I am selecting utilities for the home is because, again, what I am doing is I am mitigating the loss of service to those structures.

So I am protecting residential facilities but in order to get the value of the electrical service for the home, I need to select utilities. That is an important thing to note. And that is why it is important to think about your project beforehand and understand what you are trying to protect and also what function you are trying to protect. In this case, again, electrical services. So my project costs are $239,900 and my maintenance costs, I can estimate at approximately $1,000 per year.

So let's say I do not know the year that my property was built. That is okay. What I can do is we go back to project configuration and actually switch from historical to professional expected damages. This is because I happen to know the recurrence interval for my event. If I did not know the recurrence interval, I could not do this. But in this case, I can say, year property was built doesn't really matter and I can leave that blank. The reason we need to know the year the property was built is for the unknown recurrence interval calculator because it needs to know how frequently the hazards occurred over a specific timeframe. If you are looking for three events over 100 years versus three events over 20 years, those will be very different recurrent intervals. If I know the recurrence interval, that information is not necessary.

So now for utility type, I will again select electrical, number of customers served is 56, and then my recurrence interval is 50 years. I need to document how I determined that. In this case, we

use the applied technology councils windspeed hazard map for this location. And then looked at the hurricane Maria windspeeds for that location and determined it was approximately a 50-year windspeed event. So the impact in terms of days was 75.

So category 1, I can say is contents dollars and it is $20,000. And then displacement costs, and again, that is based on cost to lodge 56 people and the cost to feed 56 people for 75 days and that is $480,500. So now my after mitigation damages, I do have to include those and based from the project engineer or the manufacturer we know that at the 100 year event, there would still be a half-day loss of service, $5000 in contents damage but no displacement costs and now I am getting a project BCR of 1.22.

So my total benefits from this project are $308,000. My total cost including maintenance are $253,000 so my project is cost-effective. Now I can click finish and there is my BCR. I can view the report, I can print the report to a PDF and save it similar to the other projects. So now I will close out and make sure it is saved.

So the limitations of FEMA's BCA toolkit, it can do a lot of different types of projects. Garbage in is garbage out. It is a calculator. It is not intended as a data validator. So it will not tell you whether your numbers are reasonable or accurate. That is why you need to provide documentation to justify the value that you put in, specifically for a FEMA project because the FEMA BCA reviewer will not know if the values are reasonable unless you can provide justification to them. The BCA toolkit is also intended to perform BCA for physical projects, not programs, plans or regulations. This again is for structural projects for the most part. That could include things like hardening infrastructure, undergrounding power lines, installing generators, photovoltaic systems, other types of things but it cannot perform regulatory analyses.

The toolkit also assumes that hazard risk is static over the project useful life. We know this is not always the case. For example, we know that damages to infrastructure that is 50 years old will probably be greater than the same infrastructure a year after, the same piece of infrastructure, a year after it was built. As infrastructure ages we know that the damages are likely to increase, the toolkit assumes they are static. It also assumes, for example, that the hazard conditions and the probability do not change.

So it cannot estimate how the 100 year flood event might change over the life of the project. That is another issue. It can incorporate sea level rise for certain specific types of projects. But for the most part, there is the hazard risk is static over the project useful life. It also assumes that costs associated with power outages are simply a factor of the service population and the outage duration. In reality, long-term power outages might have additional escalating costs that are not captured. This is simply a limitation of the way the value of electrical service was calculated and the number of unknowns in estimating escalating damages for long-term losses of function.

So DOE has an interruption cost estimate calculator or ICE tool. This is an online tool sponsored by DOE's Office of Electricity Delivery and Energy Reliability and hosted by the Lawrence Berkeley National Laboratory which does enable users to estimate the economic cost of actual or hypothetical service outages to customers. The ICE tool is based on customer data collected by more than 30 major utilities across the U.S. It is also easy to use.

The user specifies the number of affected customers by type, location, and the duration of the outage. However, ICE is not applicable to outages lasting more than 24 hours. If you have a

short-term power outage and you believe that the BCA toolkit is underestimating your benefits, then you might want to look at the ICE calculator and see if that gives you a more accurate picture of your damages. If you have an outage greater than 24 hours however, you do have to use the FEMA BCA standard value.

ICE does have a number of users including some outside the U.S. You can find more information on the ICE calculator website. Some common BCA challenges and issues that we run into, lack of documentation for data entered. This is probably the most common one. We do not know if your jurisdiction has 10,000 people or 50,000 people so you do need to provide that type of information. Also for your damage history.

FEMA provides a number of materials that outline acceptable sources for the documentation based on the data type. Insufficient data or documentation on project effectiveness. A lot of times people will just make something up and not provide any information on where the values came from or they will not include after mitigation damages or information on project effectiveness. We cannot properly estimate what the BCR for a project is without after mitigation damages. We need to know at what point the project will fail.

The BCR will be significantly different if the project fails at the 50-year event versus a 500-year event. So you do need to provide that information and documentation for the project effectiveness. And again this can be a signed letter from the project engineer or other licensed professional. A lack of damage history. If the structure facility does not have a damage history, you can still do a benefit-cost analysis. But again, you need to have some sort of study from an engineer or other licensed professional estimating the damages and associated recurrence intervals.

You can also do a BCA for a structure that's only had one damage event as long as you know the recurrence interval for that damage event. That used to not be the case. However, we do now allow BCAs with only one damage event. Another issue is including damages that would not be mitigated by the project.

So again, if your outage was caused by a squirrel that chewed through a power line, that's probably going to still happen. Unless you completely underground the entire system, or create some sort of squirrel proof box that would not be a damage that could be included. If you are mitigating against flood damages, for example, dry floodproofing, you cannot include damages from high wind events. Lack of recurrence interval data or incorrect interpretation of recurrence intervals is another common issue.

If you have 3 or more events, lack of recurrence intervals does not preclude you from doing a BCA however if you only have two damage events, you do need to have recurrence intervals. It is also important to make sure you are using correct recurrence intervals and again those are location specific so you want to make sure that your recurrence intervals are based on the severity and the location of that hazard. Not including all protected structures, this is an issue because sometimes when FEMA reviews the BCA certain damage amounts go down. If you do not include all your protected structures, your project might no longer show as cost effective.

A lot of times, we will see cases where people stop including structures when they hit a 1.0 or 1.1. It is important to include all your structures that are going to be protected by the project in case something changes or in case your costs go up. Some BCA resources that FEMA provides, the tool help content have a lot of information on the project types and the types of

data that you need for those project types as well as where you can find them. There's also technical assistance available through the FEMA BCA helpline. These are subject matter experts who are both able to help you install and troubleshoot any software issues you might be having as well as to provide some general methodology or to answer some general methodology questions. They cannot, however, do or review your BCA for you.

State hazard mitigation officers and FEMA regional offices also can be good resources, especially if you have questions about project eligibility. Advance assistance under HMGP, BRIC and this year, PDM, can provide funding for engineering analyses and data collection to support BCAs. Advance assistance is not a guarantee that your project will get selected if you submit it. But if you are having issues getting the data that you need for a BCA, it can help with that.

FEMA's BCA training course materials are also available online. FEMA also does provide in person training through the Emergency Management Institute for states, locals, tribes, and territories. You can also request an in person training be delivered through your FEMA regional office and they can help you, they can help provide resources for that. The FEMA website, www.fema.gov/benefit-cost-analysis has a lot of useful information and also a lot of links to other resources that can help. So it is definitely worth looking there if you have questions. Does anyone have any questions? Virginia: Thank you so much. This concludes the presentation portion of our webinar.

We will now begin the Q&A session answering the questions you submitted during the presentation. We will take a moment to read through the questions you have submitted. In the meantime, we will post some webinar feedback polls. If you would like, you can also provide your organization, title, and geographic location. These are optional. But again, we really appreciate your feedback as they help make our webinars even better. Please remember that you can download both presentations from webinar 1 and webinar 2 at the bottom right-hand corner of your screen. Thank you again for joining the webinar Demonstrating Value, How to Use Benefit-cost analysis to Evaluate Energy Mitigation Projects.

[Event Concluded]